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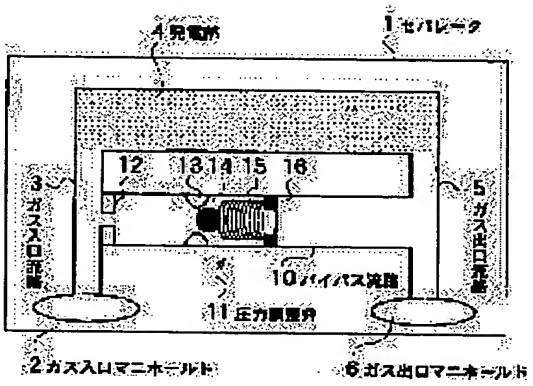
(71)Applicant : NISSAN MOTOR CO LTD
(72)Inventor : IWAI TAKESHI

(54) FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To enhance exhausting of water drops clogging a gas passage without remarkably increasing the capacity and strength of a gas system of a fuel cell and without increasing fuel gas being exhausted not contributing to cell reaction.
SOLUTION: This fuel cell is equipped with a gas inlet passage 2 connecting an gas inlet manifold 2 for supplying fuel gas or oxidizing gas and a power generating part 4 of each unit cell; a gas outlet passage 5 connecting a gas outlet manifold 6 exhausting the gas and the power generating part 4 of each unit cell; a bypass passage 10 communicating the gas inlet passage 3 with the gas outlet passage 5 every unit cell; and a pressure regulating valve 11 installed within the bypass passage, and opening/closing the bypass passage according to the inlet pressure of the bypass passage 10. When the gas passage in the power generating part 4 is clogged by water drops, the pressure regulating valve 11 opens/closes the bypass passage 10, and repeatedly increases/decrease the pressure in the gas inlet passage 3 to exhaust water drops by which the gas passage is clogged.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The fuel cell which is equipped with the stack structure which is characterized by providing the following, and which carried out two or more laminatings of the single cell, supplies fuel gas and oxidization gas to the aforementioned single cell, respectively, and is generated according to electrochemical reaction. Gas inlet passage for every single cell which connects the gas inlet manifold and the power generation section of each aforementioned ** cell which supply fuel gas or oxidization gas. Gas outlet passage for every single cell which connects the gas outlet manifold and the power generation section of each aforementioned ** cell which discharge fuel gas or oxidization gas. Bypass passage which opens the aforementioned gas inlet passage and the aforementioned gas outlet passage for free passage for every single cell. The pressure regulation mechanism which is established in this bypass passage, and opens and closes this bypass passage according to the inlet pressure of this bypass passage.
[Claim 2] The fuel cell according to claim 1 which equips the entrance section of the aforementioned bypass passage with an orifice, and is characterized by the bore of this orifice being 1/10 or less [of the bore of the aforementioned bypass passage].
[Claim 3] The fuel cell according to claim 1 to which capacity of the aforementioned bypass passage of an upstream is characterized by being smaller than the capacity of the aforementioned bypass passage of the aforementioned pressure regulation mechanism to a downstream from the aforementioned pressure regulation mechanism.
[Claim 4] The fuel cell according to claim 1 to which the cross section of the aforementioned bypass passage of an upstream is characterized by being smaller than the cross section of the aforementioned bypass passage of the aforementioned pressure regulation mechanism to a downstream from the aforementioned pressure regulation mechanism.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the fuel cell which improved the discharging efficiency of waterdrop in detail about a fuel cell.
[0002]
[Description of the Prior Art] The fuel cell is known as a power plant which can realize a high energy conversion efficiency, in order to change into direct electrical energy the chemical energy which a fuel has, without going via heat energy or mechanical energy.
[0003] This fuel cell receives supply of the oxidation gas which contains oxygen in an anode plate (air pole), and receives supply of the fuel gas which contains hydrogen in cathode (fuel electrode). In cathode, hydrogen ionizes according to the electrochemical reaction shown in (1) type, and it becomes a hydrogen ion and an electron. An electron arrives at an anode plate through an external circuit, and a hydrogen ion moves to an anode plate in the inside of an electrolyte. In an anode plate, water arises according to the electrochemical reaction shown in (2) types. It means that the chemical reaction of (3) types had arisen as the whole fuel cell.
[0004]
[Equation 1]
$H2 \rightarrow 2H^+ + 2e^-$ -- (1)
$(1/2)\ O2 + 2H^+ + 2e^- \rightarrow H2O$ -- (2)
$H2 + (1/2)\ O2 \rightarrow H2O$ -- (3)
[0005] Thus, in the electrochemical reaction in a fuel cell, water arises from hydrogen and oxygen. Moreover, it may produce un-arranging [of a steam being added to fuel gas or oxidation gas, and a steam and generation water accomplishing waterdrop inside a fuel cell in order to prevent desiccation of the electrolyte layer of a fuel cell, and closing a gas passageway]. The fuel cell of a solid-state macromolecule mold is listed for an example below, and the problem of the waterdrop produced in each part in a fuel cell is explained.
[0006] The parts which condensation of water takes place and un-arranging produces are an electrode and a gas passageway. When a gas passageway is furthermore explained in detail, it is the gas passageway (gas outlet manifold) which penetrates the outlet portion to the gas passageway which penetrates a fuel cell stack from the gas passageway inside (a) each ** cel, and the gas passageway inside (b) each ** cel, and (c) fuel cell stack.
[0007] It is thought that condensation of the steam in these parts takes place as follows. First, by the anode plate side, the reaction of the above-mentioned (2) formula occurs, the oxygen-content child in the hydrogen ion which has moved the electrolyte film, and oxidation gas reacts, and water generates. Since the hydrogen ion which moves an electrolyte film moves to an anode plate side with the water molecule of the perimeter, with these water molecules and the above-mentioned generation water, inside the gas diffusion electrode of an anode plate, moisture may be in a superfluous condition and the water screen may produce it. Moreover, even if it does not condense inside a gas diffusion electrode, it may condense by the gas passageway in a cel.
[0008] Furthermore, when waterdrop becomes a certain amount of magnitude, the water condensed by the gas passageway in this cel not only stops at the gas passageway in a cel as

waterdrop, but may flow out to the outlet portion from the gas passageway in a cel to a gas discharge manifold. Near the outlet to a gas discharge manifold, although waterdrop is held with the surface tension, if waterdrop becomes to some extent large, it will come to flow in in a gas discharge manifold further.

[0009] Although the waterdrop in a gas discharge manifold has flowed from the above-mentioned gas passageway in a cel, what the steam contained in fuel gas or oxidation gas otherwise condensed is contained. As mentioned already, the water molecule in an electrolyte film will also move toward an anode plate side with migration of a hydrogen ion, and an electrolyte film will dry from a cathode side. Since electric resistance becomes high and an electrolyte film stops functioning as an electrolyte when it dries, the steam of the specified quantity was added to the fuel gas supplied to a cathode side, and it has prevented desiccation of an electrolyte film to it. Since the water vapor content applied to this fuel gas is usually superfluous, the steam which was not absorbed by the electrolyte film remains also in the fuel gas discharged from each cel.

[0010] Although it is not necessary to add a steam to oxidation gas for the reaction by the side of an anode plate, when supplying the oxidation gas which pressurized the anode plate side and worrying about desiccation of an electrolyte film, a steam may be added also to oxidation gas. Moreover, in order for the water produced at the reaction by the side of an anode plate and the water which has moved the electrolyte film to evaporate in the oxidation gas discharged from each cel and to join it, the vapor pressure has reached abbreviation saturated water vapor pressure.

[0011] In the fuel cell with which the gas containing such a steam flows the interior, when the temperature of the exterior of this fuel cell falls, the steam in oxidation gas may condense in the field to which the temperature of the wall surface of a gas manifold also fell to, and temperature fell. Moreover, when the interior of a stack has not fully carried out a temperature up yet at the time of starting of a fuel cell, and saturated water vapor pressure falls, condensation of a steam takes place [when the operating temperature of a stack falls, or]. Condensation of the steam in the gas seen at the time of the fall of the operating temperature of a stack and starting of a fuel cell may take place by the whole gas passageway formed in the interior of stacks, such as not only a gas manifold but each gas passageway in a cel.

[0012] Since diffusion of the gas within an electrode is checked when condensation of such a steam takes place inside a gas diffusion electrode, in a gas diffusion electrode, the field which is not a carrier eclipse produces supply of gas, and the increment in electrode resistance and the fall of the output current are caused. Moreover, since the gas passageway in a cel is closed by waterdrop when condensation takes place by the gas passageway in a cel, in a gas diffusion electrode, the field which is not a carrier eclipse produces supply of gas too.

[0013] When waterdrop arises into the outlet portion from the gas passageway in a cel to a gas discharge manifold, supply of the gas to the gas passageway in a cel which had the outlet taken up will be overdue. Furthermore, when waterdrop arises in a gas manifold, there is a possibility that this waterdrop may close a connection with each gas passageway in a cel. Thus, since it becomes the cause of worsening generating efficiency also when condensation takes place where in a stack, the waterdrop produced in the stack must be discharged promptly.

[0014] It is establishing the slit structure of working in a gas supply manifold, moving this slit as technology of removing such condensed waterdrop conventionally, and closing the gas passageway of some cels, the quantity of gas flow and pressure which are supplied to the remaining cels were increased temporarily, and the method of blowing away and removing the waterdrop which had closed the gas passageway was proposed (for example, refer to JP,9-312168,A).

[0015]

[Problem(s) to be Solved by the Invention] However, by the above-mentioned conventional method, even if it could blow away the waterdrop in a gas manifold easily, it had the trouble of being hard to acquire the discharge effect from the gas passageway in a gas diffusion electrode and a single cel, and the gas passageway in a single cel to the waterdrop condensed near the outlet to a gas manifold.

[0016] Even if this changes the flow rate and pressure of gas which are supplied to a fuel cell by

the gas transfer unit side, the flow rate and pressure of the gas which reaches the part which waterdrop has actually produced are because it does not change so much. Since the fuel cell is made into the stack structure which carried out two or more laminatings of the single cel, when gas is distributed to each ** cel, a changed part of gas supply volume will also be divided according to the number of cels of a fuel cell. For this reason, it became inadequate [the flow rate of gas or the variation of a pressure which are supplied to the part which waterdrop produced], and even if it changed the flow rate and pressure of gas which are supplied to a fuel cell, removal of waterdrop might not be performed as a result.
[0017] Since this changed the flow rate and pressure of gas which are supplied to a fuel cell to the degree of pole, and it needed large strengthening of the capacity of ** and the gas network of a fuel cell, and reinforcement for it if it was **** when it tended to change the quantity of gas flow and pressure of a waterdrop generating part to reverse to the degree to which removal of waterdrop is performed effectively, the trouble that adoption was difficult was in it structural.
[0018] Moreover, when the flow rate or pressure of fuel gas was changed and waterdrop was removed, the fuel gas discharged without contributing to a cell reaction increased, and there was a trouble of reducing generating efficiency. This trouble shortens the distance it can run with the fuel of the specified quantity for a fuel cell in a power supply and ********** vehicles, and leads to the trouble of reducing the fuel consumption engine performance.
[0019] The purpose of this invention is offering the fuel cell which raised the discharging efficiency of the waterdrop which closed the gas passageway, without [without it needs strengthening with the capacity of the gas network of a fuel cell and reinforcement large in view of the above trouble, and] making the fuel gas discharged without contributing to a cell reaction increase.
[0020]
[Means for Solving the Problem] In a fuel cell which this invention according to claim 1 is equipped with stack structure which carried out two or more laminatings of the single cel in order to attain the above-mentioned purpose, supplies fuel gas and oxidation gas to said single cel, respectively, and is generated according to electrochemical reaction Gas inlet passage for every single cel which connects a gas inlet manifold which supplies fuel gas or oxidation gas, and the generation-of-electrical-energy section of each of said ** cel, Gas outlet passage for every single cel which connects a gas outlet manifold which discharges fuel gas or oxidation gas, and the generation-of-electrical-energy section of each of said ** cel, Let it be a summary to have had bypass passage which opens said gas inlet passage and said gas outlet passage for free passage for every single cel, and a pressure-regulator style which are prepared in this bypass passage, and open and close this bypass passage according to an inlet pressure of this bypass passage.
[0021] In order that this invention according to claim 2 may attain the above-mentioned purpose, in a fuel cell according to claim 1, it equips the entrance section of said bypass passage with an orifice, and makes it a summary for a bore of this orifice to be 1/10 or less [of a bore of said bypass passage].
[0022] In order that this invention according to claim 3 may attain the above-mentioned purpose, in a fuel cell according to claim 1, capacity of said bypass passage of the upstream makes it a summary to be smaller than capacity of said bypass passage of the downstream from said pressure-regulator style from said pressure-regulator style.
[0023] In order that this invention according to claim 4 may attain the above-mentioned purpose, in a fuel cell according to claim 1, the cross section of said bypass passage of the upstream makes it a summary to be smaller than the cross section of said bypass passage of the downstream from said pressure-regulator style from said pressure-regulator style.
[0024]
[Effect of the Invention] In the fuel cell which according to this invention of claim 1 is equipped with the stack structure which carried out two or more laminatings of the single cel, supplies fuel gas and oxidation gas to said single cel, respectively, and is generated according to electrochemical reaction The gas inlet passage for every single cel which connects the gas inlet manifold which supplies fuel gas or oxidation gas, and the generation-of-electrical-energy

section of each of said ** cel, The gas outlet passage for every single cel which connects the gas outlet manifold which discharges fuel gas or oxidation gas, and the generation-of-electrical-energy section of each of said ** cel, Since it had the bypass passage which opens said gas inlet passage and said gas outlet passage for free passage for every single cel, and the pressure-regulator style which are prepared in this bypass passage, and open and close this bypass passage according to the inlet pressure of this bypass passage The pressure of the gas inlet passage of a single cel where the gas passageway was closed with waterdrop rises, and it is effective in waterdrop being certainly removable with the pressure wave which a pressure-regulator style carries out repeat closing motion of the bypass passage, and produces with this pressure.

[0025] Since only the single cel which needs waterdrop discharge since a pressure-regulator style is furthermore prepared for every single cel and it can operate opens and closes bypass passage, the gas discharged without being used for a generation of electrical energy is reduced, and it is effective in preventing fuel consumption aggravation.

[0026] Since according to this invention of claim 2 in addition to the effect of the invention of claim 1 the bypass passage entrance section was equipped with the orifice and the bore of this orifice carried out to 1/10 or less [of the bore of bypass passage], the capacity to which a pressure-regulator style does not operate and which usually sometimes leaks bypass passage is reduced, and it is effective in the ability to control aggravation of specific fuel consumption further.

[0027] according to this invention of claim 3 -- the effect of the invention of claim 1 -- in addition, since the capacity of the bypass passage of the upstream made it smaller than the capacity of the bypass passage of a pressure-regulator style to the downstream from the pressure-regulator style, open time amount of a pressure-regulator style is shortened, a closing motion period is shortened, and it is effective in waterdrop being promptly removable.

[0028] according to this invention of claim 4 -- the effect of the invention of claim 1 -- in addition, since the cross section of the bypass passage of the upstream made it smaller than the cross section of the bypass passage of a pressure-regulator style to the downstream from the pressure-regulator style, open time amount of a pressure-regulator style is shortened, a closing motion period is shortened, and it is effective in waterdrop being promptly removable.

[0029]

[Embodiment of the Invention] With reference to a drawing, the operation gestalt of this invention is explained below at details. Drawing 1 is a mimetic diagram explaining the gas passageway in the 1st operation gestalt of the fuel cell concerning this invention. Since a gas passageway is the same configuration as the object for fuel gas, and the object for oxidation gas, it is not distinguished by the following explanation.

[0030] The gas inlet manifold 2 which penetrates this separator 1 to the separator 1 inserted between the cels which constitute a fuel cell stack, respectively, and the gas outlet manifold 6 are formed. The gas inlet passage 3 and the gas outlet passage 5 are open for free passage, respectively between the generation-of-electrical-energy section 4 of each cel embedded at the separator 1, and the gas inlet manifold 2 and the gas outlet manifold 6.

[0031] And the bypass passage 10 which opens the gas inlet passage 3 and the gas outlet passage 5 for free passage for every cel is formed. The pressure regulating valve 11 is formed in the interior of the bypass passage 10 as a pressure-regulator style which opens and closes the bypass passage 10 by the inlet pressure of the bypass passage 10.

[0032] The pressure regulating valve 11 is constituted by the height 16 to which the valve-seat section 13 which extracts the bore of the bypass passage 10 thinly, the globular form valve element 14, the coil spring 15 which forces a valve element 14 on the valve-seat section 13, and the valve element 14 of a coil spring 15 stop the edge of reverse. Since this pressure regulating valve 11 is aimed at the humidified gas or oxidation gas, as that configuration member, its corrosion resistance metal or plastics, such as stainless steel, are desirable.

[0033] The force by the differential pressure of the input pressure of the bypass passage 10 and an output pressure and the force by the coil spring 15 are applied to the valve element 14 of a pressure regulating valve 11. And if the upstream gas outlet passage 5 is blockaded with

waterdrop and input pressure increases from the generation-of-electrical-energy section 4 or a bypass passage connection, a pressure regulating valve 11 will open.
[0034] Moreover, in order to make area of entrance opening small, the orifice 12 is formed in the entrance of the bypass passage 10.
[0035] Next, actuation of the 1st operation gestalt shown in drawing 1 is explained. Usually, during operation, distributed gas is supplied to the interior of the generation-of-electrical-energy section 4 through the gas inlet passage 3 from the gas inlet manifold 2, and is consumed by the electrochemical reaction by generation of electrical energy. The component of the distributed gas which was not consumed is discharged through the gas outlet passage 5 to the gas discharge manifold 6.
[0036] By the usual gas supply pressure, it has closed and the gas passageway prepared in the interior of the generation-of-electrical-energy section 4 is closed by waterdrop, and the pressure regulating valve 11 is designed so that it may open, when there is a pressure buildup of the gas inlet passage 3.
[0037] If there is no coagulation of waterdrop etc. in the gas passageway of the generation-of-electrical-energy section 4, since the differential pressure of the gas inlet passage 3 and the gas outlet passage 5 is small, although the pressure regulating valve 11 is closed, the force by the differential pressure of the pressure of the gas inlet passage 3 and the pressure of the gas outlet passage 5 will exceed the force of a coil spring 15, and if waterdrop closes the gas passageway of the generation-of-electrical-energy section 4, a pressure regulating valve 11 will open it.
[0038] If a pressure regulating valve 11 opens, since gas will flow from the gas inlet passage 3 to the gas outlet passage 5 through the bypass passage 10, the differential pressure of the gas inlet passage 3 and the gas outlet passage 5 becomes small, and a pressure regulating valve 11 closes again. If the internal gas passageway of the generation-of-electrical-energy section 4 is still closed when a pressure regulating valve 11 closes, the pressure of the gas inlet passage 3 will increase again, and a pressure regulating valve 11 will become open Lycium chinense again.
[0039] By repeating this switching action by the pressure regulating valve 11, the gas pressure supplied to the generation-of-electrical-energy section 4 can change, and the waterdrop which closed the gas passageway of the generation-of-electrical-energy section 4 interior can be discharged. Furthermore, since a pressure regulating valve 11 repeats a switching action repeatedly until the waterdrop which closed the gas passageway is discharged, it can discharge certainly the waterdrop which closed the gas passageway.
[0040] Drawing 2 is time amount change of the generation-of-electrical-energy voltage of the single cel at the time of waterdrop closing a gas passageway, and the gas-passageway pressure in a cel. If the solidified waterdrop closes the gas passageway in a cel, while the generation-of-electrical-energy voltage of the cel concerned will fall rapidly, the pressure of gas inlet passage rises. What is necessary is just to set the load rate of a coil spring 15 that a pressure regulating valve 11 opens by the gas inlet pressure when generation-of-electrical-energy voltage usually falling by 0.4V from the time, if the allowed value on layout for sag by waterdrop is set to 0.4V here.
[0041] Moreover, in layout of this bypass passage 10, as shown in drawing 3 , the field and its capacity from "A" and a pressure regulating valve 11 to bypass passage 10 outlet are set to "B" for the field and its capacity from bypass passage 10 entrance to a pressure regulating valve 11. The waterdrop removal effect by pressure fluctuation falls as the volume ratio [A/B] of these two fields becomes large. Moreover, the flowing quantity of gas flow increases the bypass passage 10 at the time of actuation of a pressure regulating valve 11, and specific fuel consumption also gets worse as a volume ratio [A/B] becomes large. About this, when the pressure variation of Field A and Field B was considered, it became like drawing 4 . In addition, drawing 4 is what showed the time amount change of the pressure of Field A and Field B by closing motion of a pressure regulating valve 11, and assumes continuation in the condition that the gas passageway of the generation-of-electrical-energy section 4 interior was closed.
[0042] The pressure of Field A rises gradually, if the generation-of-electrical-energy section 4 interior is taken up, it reaches the open pressure of a pressure regulating valve 11, and begins to

descend from the moment that this pressure regulating valve 11 is opened wide. On the other hand, the pressure of Field B begins a rise from the moment the pressure regulating valve 11 opened. Time of day which this pressure regulating valve 11 opened is set to t1. After a while, the pressure (pressure loss in case gas flows the spring pressure + field B of the pressure + pressure regulating valve 11 of Field B in detail) of Field A and Field B becomes almost equal, and a pressure regulating valve 11 closes again. Time of day which this pressure regulating valve 11 closed is set to t2. After this, again, the pressure of Field A rises and a pressure regulating valve 11 sets to t3 time of day opened wide again.

[0043] When repeating this actuation in bypass passage, time amount to which time amount, i.e., a valve, has closed the time amount from time of day t1 to time of day t2, i.e., the time amount which the valve has opened wide, from to and time of day t2 to time of day t3 is set to tc. Since there are many amounts of the gas which passes a pressure regulating valve 11 when the capacity of Field A is large, to becomes long, and since there is little capacity which passes a pressure regulating valve 11 conversely when the capacity of Field A is small, to becomes short.

[0044] Since discharge of waterdrop is not expectable even if it gives a slow gas pressure change to the generation-of-electrical-energy section 4, in order to heighten the waterdrop removal effect, to is shortened, and pressure fluctuation must be given a short period and it is necessary to make capacity of Field A sufficiently smaller than the capacity of Field B for that purpose. If this waterdrop removal effect becomes high and especially a volume ratio [A/B] becomes one or less so that the examination result of drawing 5 to a volume ratio [A/B] is small, it turns out that to becomes short and can acquire the higher waterdrop removal effect rather than tc.

[0045] Moreover, although it becomes loss gas to bypass gas by disconnection of a pressure regulating valve 11 since distributed gas is discharged without being consumed with an electrode, it is making a volume ratio [A/B] or less into one from the examination result of drawing 6 , and it turns out that it is stopped by 1/100 or less [of the quantity of gas flow to which the quantity of gas flow bypassed is supplied by the electrode].

[0046] Furthermore, although spring pressure is set up so that it may open, when waterdrop closes a gas passageway, and a pressure regulating valve 11 usually has the thing for which the gas passageway is not closed by waterdrop and by which distributed gas also sometimes leaks from a pressure regulating valve 11 since this spring pressure is not a not much big value, it is forming an orifice 12 near the entrance of the bypass passage 10, and can reduce the ullage of gas.

[0047] If an orifice 12 is formed, by the flow of the high-speed gas which flows the gas inlet passage 3 close to the entrance of the bypass passage 10, a low voltage field can occur into orifice 12 portion, the so-called ejector effect can be produced, the pressure of Field A can decline, and leak of the unnecessary gas from a pressure regulating valve 11 can be suppressed.

[0048] An example of a result which changed gas pressure and the passage lay length of the bypass passage 10 of an orifice 12, and considered the diameter of an orifice 12 and the relation of the capacity which leaks the bypass passage 10 is shown in drawing 7 in a setup of an orifice 12. In the example of this drawing 7 , when an orifice 12 is formed compared with the case where an orifice 12 is not formed, it turns out that the capacity which leaks the bypass passage 10 can be reduced to the maximum abbreviation 1/8.

[0049] In the entrance section of the bypass passage 10 shown in drawing 8 , although the gas by which close came will be divided into what flows to the bypass passage 10 in the gas inlet passage 3, and the thing which flows in the generation-of-electrical-energy section 4 from the gas inlet manifold 2 if the bore of the gas inlet passage 3 which approaches Rb and it in the bore of the bypass passage 10 is set to Rm, the flow rate is distributed in proportion to the ratio of the cross section.

[0050] Therefore, it will become drawing 9 if the relation between the inside clearance ratio [Rb/Rm] of the bypass passage 10 and the gas inlet passage 3 and the ratio of the flow rate which flows into the bypass passage 10 among the gas which has flowed from the gas inlet manifold 2 is shown. It turns out that the capacity which usually leaks the bypass passage 10 at the time of operation can be reduced or less [when not forming an orifice 12] to 1/100 by

making the diameter of an orifice 12 or less [of the bore of the gas inlet passage 3] into 1/10 from this drawing 9 .

[0051] Drawing 10 is a mimetic diagram explaining the gas passageway in the 2nd operation gestalt of the fuel cell concerning this invention. A gas passageway is the same configuration as the object for fuel gas, and the object for oxidation gas.

[0052] In this operation gestalt, it is having made thin the bore of bypass passage 10a from the entrance of the bypass passage 10 to a pressure regulating valve 11, and serving as the valve-seat section 13 of the 1st operation gestalt. Thereby, capacity of the field A of the upstream is made smaller than the pressure regulating valve 11 of the bypass passage 10, and the same effect as the 1st operation gestalt of making small capacity which leaks the bypass passage 10 as much as possible is acquired.

[0053] In addition, the operation gestalt explained above is indicated in order to understand this invention easily, and it does not limit this invention. Therefore, each element indicated by the above-mentioned operation gestalt is the meaning including the selection matter on all layout belonging to the technical range of this invention.

[0054] For example, if the class of pressure-regulator style, such as using a lead valve as a pressure-regulator style, the configuration of bypass passage, such as an installation location, etc. are designed so that a pressure-regulator style may function when waterdrop closes a gas passageway, they will not be limited to each above-mentioned operation gestalt at all.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a mimetic diagram explaining the gas passageway in the 1st operation gestalt of the fuel cell concerning this invention.
[Drawing 2] It is drawing showing time amount change of the gas-passageway pressure in a cel with the generation-of-electrical-energy voltage of the single cel at the time of waterdrop closing a gas passageway.
[Drawing 3] It is drawing showing the physical relationship of the pressure-regulating-valve upstream region A and the pressure-regulating-valve downstream region B.
[Drawing 4] It is drawing showing the pressure time amount change of the pressure-regulating-valve upstream region A and the pressure-regulating-valve downstream region B by closing motion of a pressure regulating valve.
[Drawing 5] It is drawing showing the correlation of the volume ratio [A/B] of the pressure-regulating-valve upstream region A and the pressure-regulating-valve downstream region B, and the waterdrop removal effect.
[Drawing 6] It is drawing showing the correlation of a volume ratio [A/B] and a loss flow rate.
[Drawing 7] It is drawing showing the correlation of the supply-gas-pressure force and a leak flow rate by the existence of an orifice.
[Drawing 8] It is drawing explaining division of the quantity of gas flow by the bore Rm of gas inlet passage, and the bore Rb of an orifice.
[Drawing 9] It is drawing showing the correlation of the inside clearance ratio [Rb/Rm] by the bore Rb of an orifice, and the bore Rm of gas inlet passage, and the ratio of the flow rate which flows into bypass passage among the gas which has flowed from the gas inlet manifold.
[Drawing 10] It is a mimetic diagram explaining the gas passageway in the 2nd operation gestalt of the fuel cell concerning this invention.
[Description of Notations]
1 Separator
2 Gas Inlet Manifold
3 Gas Inlet Passage
4 Generation-of-Electrical-Energy Section
5 Gas Outlet Passage
6 Gas Outlet Manifold
10 Bypass Passage
11 Pressure Regulating Valve
12 Orifice

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(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町２番地
(72)発明者　岩井　健
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内
(74)代理人　100083806
弁理士　三好　秀和　（外８名）

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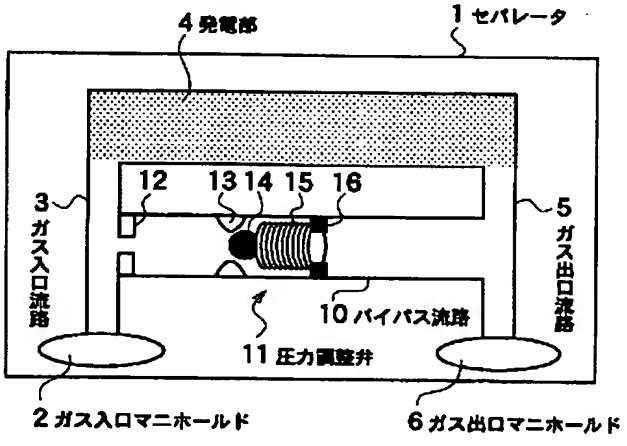
(54)【発明の名称】　燃料電池

(57)【要約】
【課題】　燃料電池のガス系統の容量及び強度の大幅な強化を必要とすることなく、また電池反応に寄与せずに排出される燃料ガスを増加させることなく、ガス流路を塞いだ水滴の排出性能を向上させる。
【解決手段】　燃料ガス又は酸化ガスを供給するガス入口マニホールド２と各単セルの発電部４とを接続するガス入口流路３と、前記ガスを排出するガス出口マニホールド６と各単セルの発電部４とを接続するガス出口流路５と、単セル毎にガス入口流路３とガス出口流路５とを連通するバイパス流路１０と、バイパス流路１０内に設けられバイパス流路１０の入口圧力に応じてバイパス流路１０を開閉する圧力調整弁１１とを備える。水滴が発電部４のガス流路を塞ぐと、圧力調整弁１１がバイパス流路１０を開閉し、ガス入口流路３の圧力を繰り返し増減することで、ガス流路を塞いでいた水滴を排出する。



【特許請求の範囲】
【請求項１】　単セルを複数積層したスタック構造を備え、前記単セルにそれぞれ燃料ガス及び酸化ガスを供給して電気化学反応により発電する燃料電池において、
燃料ガスまたは酸化ガスを供給するガス入口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス入口流路と、
燃料ガスまたは酸化ガスを排出するガス出口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス出口流路と、
単セル毎に前記ガス入口流路と前記ガス出口流路とを連通するバイパス流路と、
該バイパス流路内に設けられ該バイパス流路の入口圧力に応じて該バイパス流路を開閉する圧力調整機構と、
を備えたことを特徴とする燃料電池。
【請求項２】　前記バイパス流路の入口部にオリフィスを備え、
該オリフィスの内径が前記バイパス流路の内径の１／１０以下であることを特徴とする請求項１記載の燃料電池。
【請求項３】　前記圧力調整機構から上流側の前記バイパス流路の容積が、前記圧力調整機構から下流側の前記バイパス流路の容積よりも小さいことを特徴とする請求項１記載の燃料電池。
【請求項４】　前記圧力調整機構から上流側の前記バイパス流路の断面積が、前記圧力調整機構から下流側の前記バイパス流路の断面積よりも小さいことを特徴とする請求項１記載の燃料電池。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は燃料電池に関し、詳しくは、水滴の排出性能を改良した燃料電池に関する。
【０００２】
【従来の技術】燃料電池は、燃料が有する化学エネルギを熱エネルギや機械エネルギを経由することなく直接電気エネルギに変換するため、高いエネルギ変換効率が実現可能な発電装置として知られている。
【０００３】この燃料電池は、陽極（空気極）に酸素を含有する酸化ガスの供給を受け、陰極（燃料極）に水素を含有する燃料ガスの供給を受ける。陰極では（１）式に示す電気化学反応により水素が電離して水素イオンと電子になる。電子は外部回路を通じて陽極に到達し、水素イオンは陽極まで電解質中を移動する。陽極では、（２）式に示す電気化学反応により水が生じる。燃料電池全体としては、（３）式の化学反応が生じたことになる。
【０００４】
【数１】
$H_2 \rightarrow 2H^+ + 2e^-$　　…（１）
$(1/2)O_2 + 2H^+ + 2e^- \rightarrow H_2O$　　…（２）
$H_2 + (1/2)O_2 \rightarrow H_2O$　　…（３）
【０００５】このように、燃料電池における電気化学反応では、水素と酸素から水が生じる。また燃料電池の電解質層の乾燥を防ぐ目的で、燃料ガスや酸化ガスには水蒸気が加えられることがあり、燃料電池内部では水蒸気や生成水が水滴を成してガス流路を塞いでしまうという不都合を生じることがある。以下に固体高分子型の燃料電池を例に挙げて、燃料電池内の各部で生じる水滴の問題について説明する。
【０００６】水の凝縮が起こって不都合が生じる箇所は、電極とガス流路である。さらにガス流路を詳しく説明すると、（ａ）各単セル内部のガス流路、（ｂ）各単セル内部のガス流路から燃料電池スタックを貫通するガス流路への出口部分、（ｃ）燃料電池スタックを貫通するガス流路（ガス出口マニホールド）である。
【０００７】これらの箇所における水蒸気の凝縮は、次のようにして起こると考えられる。まず陽極側では上記（２）式の反応が起こり、電解質膜を移動してきた水素イオンと酸化ガス中の酸素分子が反応して水が生成する。電解質膜を移動する水素イオンは、その周囲の水分子とともに陽極側へ移動するので、これらの水分子と上記生成水とによって、陽極のガス拡散電極内部では水分が過剰な状態となり、水膜が生じることがある。また、ガス拡散電極内部で凝縮しなくても、セル内ガス流路で凝縮することもある。
【０００８】さらに、このセル内ガス流路で凝縮した水は、セル内ガス流路に水滴として留まるだけでなく、水滴がある程度の大きさになると、セル内ガス流路からガス排出マニホールドへの出口部分まで流れ出すこともある。ガス排出マニホールドへの出口付近では水滴はその表面張力によって保持されるが、水滴がある程度大きくなると、さらにガス排出マニホールド内に流れ込むようになる。
【０００９】ガス排出マニホールド内の水滴は、上記のセル内ガス流路から流れてきたものの他に、燃料ガスや酸化ガス中に含まれる水蒸気が凝縮したものも含まれる。既述したように水素イオンの移動にともない、電解質膜中の水分子も陽極側に向かって移動し、電解質膜が陰極側から乾燥してしまう。電解質膜は乾燥すると、電気抵抗が高くなり、電解質として機能しなくなるため、陰極側に供給される燃料ガスには、所定量の水蒸気が加えられ電解質膜の乾燥を防いでいる。この燃料ガスに加えられる水蒸気量が通常は過剰なため、各セルから排出された燃料ガスにも、電解質膜に吸収されなかった水蒸気が残っている。
【００１０】酸化ガスには、陽極側の反応のために水蒸気を加える必要はないが、陽極側に加圧した酸化ガスを供給する場合など、電解質膜の乾燥が心配される場合には、酸化ガスにも水蒸気を加える場合がある。また、各セルから排出された酸化ガスには、陽極側の反応で生じ

た水や電解質膜を移動してきた水が蒸発して加わるため、その蒸気圧は略飽和水蒸気圧に達している。

【００１１】このような水蒸気を含んだガスが内部を流れる燃料電池において、たとえばこの燃料電池の外部の温度が低下したときには、ガスマニホールドの壁面の温度も低下してしまい、温度が低下した領域で、酸化ガス中の水蒸気が凝縮してしまうことがある。また、スタックの運転温度が低下したときや、燃料電池の起動時にまだスタック内部が充分に昇温していないとき等にも、飽和水蒸気圧が下がることによって水蒸気の凝縮が起こる。スタックの運転温度の低下時や燃料電池の起動時に見られるガス中の水蒸気の凝縮は、ガスマニホールドだけでなく、各セル内ガス流路などスタック内部に形成されたガス流路全体で起こり得る。

【００１２】このような水蒸気の凝縮がガス拡散電極内部で起こった場合、電極内でのガスの拡散が阻害されるため、ガス拡散電極においてガスの供給を受けられない領域が生じ、電極抵抗の増加や出力電流の低下を引き起こす。また、セル内ガス流路で凝縮が起こった場合には、水滴によってセル内ガス流路が塞がれるため、やはりガス拡散電極においてガスの供給を受けられない領域が生じる。

【００１３】セル内ガス流路からガス排出マニホールドへの出口部分に水滴が生じた場合には、出口を塞がれたセル内ガス流路へのガスの供給が滞ってしまう。さらに、ガスマニホールドに水滴が生じた場合には、この水滴が各セル内ガス流路との接続部を塞いでしまうおそれがある。このように、スタック内のどこで凝縮が起こった場合にも、発電効率を悪化させる原因となるため、スタック内に生じた水滴は速やかに排出されなければならない。

【００１４】従来、このような凝縮した水滴を除去する技術としては、ガス供給マニホールド内に可動式のスリット構造を設け、このスリットを移動させて一部のセルのガス流路を塞ぐことで、残りのセルに供給されるガス流量や圧力を一時的に増大させ、ガス流路を塞いでいた水滴を吹き飛ばして除去する方法が提案されていた（例えば特開平９－３１２１６８号公報参照）。

【００１５】

【発明が解決しようとする課題】しかしながら、上記従来の方法では、ガスマニホールド内の水滴は容易に吹き飛ばすことができても、ガス拡散電極内や単セル内のガス流路及び単セル内ガス流路からガスマニホールドへの出口付近で凝縮した水滴に対しては、排出効果が得にくいという問題点があった。

【００１６】これは、燃料電池に供給するガスの流量や圧力をガス供給装置側で変化させても、実際に水滴が生じている箇所に達するガスの流量や圧力はさほど変化しないことによる。燃料電池は単セルを複数積層したスタック構造としているため、各単セルにガスが分配されるときには、燃料電池のセル数に応じてガス供給量の変化分もまた分割されてしまう。このため、水滴が生じた箇所に供給されるガスの流量や圧力の変化量は不十分となり、燃料電池に供給するガスの流量や圧力を変化させても結果的に水滴の除去が行われないことがあった。

【００１７】これとは逆に、水滴の除去が効果的に行われる程度まで水滴発生箇所のガス流量や圧力を変化させようとすると、燃料電池に供給するガスの流量や圧力を極度に変化させねばならず、燃料電池のガス系統の容量及び強度の大幅な強化を必要とするので、機構的に採用が困難であるという問題点があった。

【００１８】また、燃料ガスの流量または圧力を変化させて水滴を除去する場合、電池反応に寄与することなく排出される燃料ガスが増加し、発電効率を低下させるという問題点があった。この問題点は、燃料電池を電源とした燃料電池車両において、所定量の燃料で走行可能な距離を短縮させ、燃費性能を低下させるという問題点に繋がる。

【００１９】以上の問題点に鑑み、本発明の目的は、燃料電池のガス系統の容量及び強度の大幅な強化を必要とすることなく、また電池反応に寄与せずに排出される燃料ガスを増加させることなく、ガス流路を塞いだ水滴の排出性能を向上させた燃料電池を提供することである。

【００２０】

【課題を解決するための手段】請求項１記載の本発明は、上記目的を達成するため、単セルを複数積層したスタック構造を備え、前記単セルにそれぞれ燃料ガス及び酸化ガスを供給して電気化学反応により発電する燃料電池において、燃料ガスまたは酸化ガスを供給するガス入口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス入口流路と、燃料ガスまたは酸化ガスを排出するガス出口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス出口流路と、単セル毎に前記ガス入口流路と前記ガス出口流路とを連通するバイパス流路と、該バイパス流路内に設けられ該バイパス流路の入口圧力に応じて該バイパス流路を開閉する圧力調整機構と、を備えたことを要旨とする。

【００２１】請求項２記載の本発明は、上記目的を達成するため、請求項１記載の燃料電池において、前記バイパス流路の入口部にオリフィスを備え、該オリフィスの内径が前記バイパス流路の内径の１／１０以下であることを要旨とする。

【００２２】請求項３記載の本発明は、上記目的を達成するため、請求項１記載の燃料電池において、前記圧力調整機構から上流側の前記バイパス流路の容積が、前記圧力調整機構から下流側の前記バイパス流路の容積よりも小さいことを要旨とする。

【００２３】請求項４記載の本発明は、上記目的を達成するため、請求項１記載の燃料電池において、前記圧力調整機構から上流側の前記バイパス流路の断面積が、前

記圧力調整機構から下流側の前記バイパス流路の断面積よりも小さいことを要旨とする。

【００２４】

【発明の効果】請求項１の本発明によれば、単セルを複数積層したスタック構造を備え、前記単セルにそれぞれ燃料ガス及び酸化ガスを供給して電気化学反応により発電する燃料電池において、燃料ガスまたは酸化ガスを供給するガス入口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス入口流路と、燃料ガスまたは酸化ガスを排出するガス出口マニホールドと前記各単セルの発電部とを接続する単セル毎のガス出口流路と、単セル毎に前記ガス入口流路と前記ガス出口流路とを連通するバイパス流路と、該バイパス流路内に設けられ該バイパス流路の入口圧力に応じて該バイパス流路を開閉する圧力調整機構と、を備えたので、水滴によりガス流路が塞がれた単セルのガス入口流路の圧力が上昇し、この圧力によって圧力調整機構がバイパス流路を繰り返し開閉して生じる圧力波により確実に水滴を除去することができるという効果がある。

【００２５】さらに圧力調整機構は、単セル毎に設けられて動作可能となっているので、水滴排出を必要とする単セルのみバイパス流路を開閉するので、発電に利用されずに排出されるガスを低減し、燃費悪化を防止するという効果がある。

【００２６】請求項２の本発明によれば、請求項１の発明の効果に加えて、バイパス流路入口部にオリフィスを備え、このオリフィスの内径がバイパス流路の内径の１／１０以下としたので、圧力調整機構が作動しない通常時にバイパス流路をリークするガス量を低減し、燃料消費率の悪化をさらに抑制することができるという効果がある。

【００２７】請求項３の本発明によれば、請求項１の発明の効果に加えて、圧力調整機構から上流側のバイパス流路の容積が、圧力調整機構から下流側のバイパス流路の容積よりも小さくしたので、圧力調整機構の開時間を短くして開閉周期を短縮し、速やかに水滴を除去することができるという効果がある。

【００２８】請求項４の本発明によれば、請求項１の発明の効果に加えて、圧力調整機構から上流側のバイパス流路の断面積が、圧力調整機構から下流側のバイパス流路の断面積よりも小さくしたので、圧力調整機構の開時間を短くして開閉周期を短縮し、速やかに水滴を除去することができるという効果がある。

【００２９】

【発明の実施の形態】以下に図面を参照して、本発明の実施形態を詳細に説明する。図１は、本発明に係る燃料電池の第１の実施形態におけるガス流路を説明する模式図である。ガス流路は、燃料ガス用と酸化ガス用と同一構成であるので、以下の説明では、区別しない。

【００３０】燃料電池スタックを構成するセル間に挟まれるセパレータ１に、このセパレータ１をそれぞれ貫通するガス入口マニホールド２と、ガス出口マニホールド６とを設ける。セパレータ１に埋め込まれた各セルの発電部４と、ガス入口マニホールド２及びガス出口マニホールド６との間は、それぞれガス入口流路３及びガス出口流路５により連通されている。

【００３１】そして、セル毎にガス入口流路３及びガス出口流路５とを連通するバイパス流路１０を設ける。バイパス流路１０の内部には、バイパス流路１０の入口圧力によりバイパス流路１０を開閉する圧力調整機構として圧力調整弁１１が設けられている。

【００３２】圧力調整弁１１は、バイパス流路１０の内径を細く絞るバルブシート部１３と、球形の弁体１４と、弁体１４をバルブシート部１３に押しつけるコイルバネ１５と、コイルバネ１５の弁体１４とは逆の端部を係止する突起部１６により構成されている。この圧力調整弁１１は、加湿されたガスまたは酸化ガスを対象としているので、その構成部材としては、ステンレス等の耐食性の金属またはプラスチックが好ましい。

【００３３】圧力調整弁１１の弁体１４には、バイパス流路１０の入口側圧力と出口側圧力との圧力差による力と、コイルバネ１５による力とが掛かっている。そして、発電部４またはバイパス流路接続部より上流のガス出口流路５が水滴で閉塞されて、入口側圧力が高まると、圧力調整弁１１が開くようになっている。

【００３４】また、バイパス流路１０の入口には、入口開口部の面積を小さくするためにオリフィス１２が設けられている。

【００３５】次に、図１に示した第１の実施形態の動作を説明する。通常運転中には、供給ガスはガス入口マニホールド２からガス入口流路３を通って発電部４の内部に供給され、発電による電気化学反応で消費される。消費されなかった供給ガスの成分は、ガス出口流路５を通ってガス排出マニホールド６へと排出される。

【００３６】圧力調整弁１１は、通常のガス供給圧力では閉じており、発電部４の内部に設けられたガス流路が水滴によって塞がれ、ガス入口流路３の圧力上昇があった場合に開くよう設計されている。

【００３７】発電部４のガス流路に水滴の凝結等がなければ、ガス入口流路３とガス出口流路５との圧力差は小さいので圧力調整弁１１は閉じているが、水滴が発電部４のガス流路を塞ぐと、ガス入口流路３の圧力とガス出口流路５の圧力との圧力差による力がコイルバネ１５の力を上回って圧力調整弁１１が開く。

【００３８】圧力調整弁１１が開くと、ガス入口流路３からバイパス流路１０を経てガス出口流路５へガスが流れるため、ガス入口流路３とガス出口流路５の圧力差が小さくなり、再び圧力調整弁１１が閉じる。圧力調整弁１１が閉じたとき、まだ発電部４の内部ガス流路が塞がれていると、再びガス入口流路３の圧力が高まり、再度

圧力調整弁１１が開くことになる。

【００３９】圧力調整弁１１によるこの開閉動作が繰り返されることによって、発電部４に供給されるガス圧力が変化し、発電部４内部のガス流路を塞いだ水滴を排出することができる。さらに、圧力調整弁１１はガス流路を塞いだ水滴が排出されるまで、何度も開閉動作を繰り返すため、ガス流路を塞いだ水滴を確実に排出することができる。

【００４０】図２は、水滴がガス流路を塞いだ際の単セルの発電電圧とセル内ガス流路圧力の時間変化である。凝結した水滴がセル内ガス流路を塞ぐと、急激に当該セルの発電電圧が低下するとともに、ガス入口流路の圧力が上昇する。ここで、水滴による電圧低下分の設計上の許容値を例えば、０．４Ｖとすると、発電電圧が通常時から０．４Ｖ低下したときのガス入口圧力で圧力調整弁１１が開くようにコイルバネ１５のバネ定数を定めればよい。

【００４１】また、このバイパス流路１０の設計にあたり、図３に示すように、バイパス流路１０入口から圧力調整弁１１までの領域及びその容積を「Ａ」、圧力調整弁１１からバイパス流路１０出口までの領域及びその容積を「Ｂ」とする。これら２つの領域の容積比〔Ａ／Ｂ〕が大きくなるにしたがって、圧力変動による水滴除去効果が低下する。また、容積比〔Ａ／Ｂ〕が大きくなるにしたがって、圧力調整弁１１の動作時にバイパス流路１０を流れるガス流量が増加し、燃料消費率も悪化する。これに関して、領域Ａと領域Ｂの圧力変化を検討したところ図４のようになった。なお図４は圧力調整弁１１の開閉による領域Ａと領域Ｂの圧力の時間変化を示したもので、発電部４内部のガス流路が塞がれた状態の継続を想定している。

【００４２】領域Ａの圧力は、発電部４内部が塞がれると徐々に上昇していき、圧力調整弁１１の開放圧力に達して、この圧力調整弁１１が開放された瞬間から下降し始める。一方、領域Ｂの圧力は圧力調整弁１１の開放した瞬間から上昇を始める。この圧力調整弁１１が開いた時刻をｔ１とする。しばらくすると領域Ａと領域Ｂの圧力（より詳しくは、領域Ｂの圧力＋圧力調整弁１１のバネ圧＋領域Ｂをガスが流れるときの圧力損失）がほぼ等しくなり、圧力調整弁１１が再び閉じる。この圧力調整弁１１が閉じた時刻をｔ２とする。このあと再度、領域Ａの圧力が上昇し、圧力調整弁１１が再び開放される時刻をｔ３とする。

【００４３】バイパス流路でこの動作を繰り返すとき、時刻ｔ１から時刻ｔ２までの時間、すなわち弁が開放している時間をｔｏ、時刻ｔ２から時刻ｔ３までに時間、すなわち弁が閉じている時間をｔｃとする。領域Ａの容積が大きいときには圧力調整弁１１を通過するガスの量が多いのでｔｏは長くなり、逆に領域Ａの容積が小さいときには圧力調整弁１１を通過するガス量が少ないのでｔｏは短くなる。

【００４４】発電部４に緩慢なガス圧力変化を与えても水滴の排出は期待できないので、水滴除去効果を高めるためには、ｔｏを短くして短周期で圧力変動を与えなければならず、そのためには領域Ａの容積を領域Ｂの容積よりも充分小さくする必要がある。図５の検討結果から容積比〔Ａ／Ｂ〕が小さいほど、この水滴除去効果は高くなり、特に容積比〔Ａ／Ｂ〕が１以下ならば、ｔｏがｔｃよりも短くなり、より高い水滴除去効果を得られることがわかる。

【００４５】また、圧力調整弁１１の開放によってガスをバイパスすることは、供給ガスが電極で消費されずに排出されることなので、損失ガスになるが、図６の検討結果から容積比〔Ａ／Ｂ〕を１以下にすることで、バイパスされるガス流量を電極に供給されるガス流量の１／１００以下に抑えられることがわかる。

【００４６】さらに、圧力調整弁１１は、ガス流路を水滴が塞ぐことによって開放するようにバネ圧が設定されており、このバネ圧があまり大きな値ではないため、水滴にガス流路が塞がれていない通常時にも、圧力調整弁１１から供給ガスがリークすることがあるが、バイパス流路１０の入口付近にオリフィス１２を設けることで、ガスの漏れ量を低減できる。

【００４７】オリフィス１２を設けると、バイパス流路１０の入口に近接するガス入口流路３を流れる高速のガスの流れにより、オリフィス１２部分に低圧領域が発生していわゆるイジェクタ効果を生じ、領域Ａの圧力が低下して圧力調整弁１１からの不必要なガスのリークを抑えることができる。

【００４８】オリフィス１２の設定にあたり、オリフィス１２の直径とバイパス流路１０をリークするガス量の関係をガス圧力やオリフィス１２のバイパス流路１０の流路方向の長さを変えて検討した結果の一例を図７に示す。この図７の例では、オリフィス１２を設けない場合に比べてオリフィス１２を設けた場合、バイパス流路１０をリークするガス量を最大約１／８に低減できることがわかる。

【００４９】図８に示すバイパス流路１０の入口部において、バイパス流路１０の内径をＲｂ、それに近接するガス入口流路３の内径をＲｍとすると、ガス入口マニホールド２から入ってきたガスは、ガス入口流路３でバイパス流路１０に流れるものと発電部４に流れるものに分かれるが、その流量は断面積の比に比例して分配される。

【００５０】よって、バイパス流路１０とガス入口流路３との内径比〔Ｒｂ／Ｒｍ〕と、ガス入口マニホールド２から流入してきたガスのうちバイパス流路１０に流れ込む流量の比との関係を示すと、図９になる。この図９からオリフィス１２の直径を、ガス入口流路３の内径の１／１０以下にすることで、通常運転時にバイパス流路

１０をリークするガス量をオリフィス１２を設けない場合の１／１００以下に低減できることがわかる。

【００５１】図１０は、本発明に係る燃料電池の第２の実施形態におけるガス流路を説明する模式図である。ガス流路は、燃料ガス用と酸化ガス用と同一構成である。

【００５２】本実施形態においては、バイパス流路１０の入口から圧力調整弁１１までのバイパス流路１０ａの内径を細くし、第１実施形態のバルブシート部１３を兼ねていることである。これにより、バイパス流路１０の圧力調整弁１１より上流側の領域Ａの容積を小さくし、バイパス流路１０をリークするガス量を極力小さくするという第１実施形態と同様の効果が得られる。

【００５３】なお、以上説明した実施形態は、本発明を容易に理解するために記載されたものであり、本発明を限定するものではない。したがって、上記実施形態に開示された各要素は、本発明の技術範囲に属する全ての設計上の選択事項を含む趣旨である。

【００５４】たとえば、圧力調整機構としてリードバルブを使用するなど、圧力調整機構の種類や、設置位置等、あるいはバイパス流路の形状等は、ガス流路を水滴が塞いだときに圧力調整機構が機能するように設計されていれば、上記各実施形態に何ら限定されるものではない。

【図面の簡単な説明】

【図１】本発明に係る燃料電池の第１の実施形態におけるガス流路を説明する模式図である。

【図２】水滴がガス流路を塞いだ際の単セルの発電電圧と、セル内ガス流路圧力の時間変化を示す図である。

【図３】圧力調整弁上流領域Ａと圧力調整弁下流領域Ｂの位置関係を示す図である。

【図４】圧力調整弁の開閉による圧力調整弁上流領域Ａと圧力調整弁下流領域Ｂの圧力時間変化を示す図である。

【図５】圧力調整弁上流領域Ａと圧力調整弁下流領域Ｂとの容積比〔Ａ／Ｂ〕と水滴除去効果との相関関係を示す図である。

【図６】容積比〔Ａ／Ｂ〕と損失流量との相関関係を示す図である。

【図７】オリフィスの有無で、供給ガス圧力とリーク流量との相関関係を示す図である。

【図８】ガス入口流路の内径Ｒｍとオリフィスの内径Ｒｂとによるガス流量の分割を説明する図である。

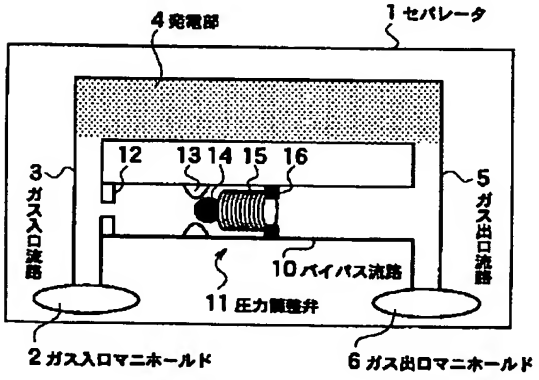
【図９】オリフィスの内径Ｒｂとガス入口流路の内径Ｒｍによる内径比〔Ｒｂ／Ｒｍ〕と、ガス入口マニホールドから流入してきたガスのうちバイパス流路に流れ込む流量の比との相関関係を示す図である。

【図１０】本発明に係る燃料電池の第２の実施形態におけるガス流路を説明する模式図である。

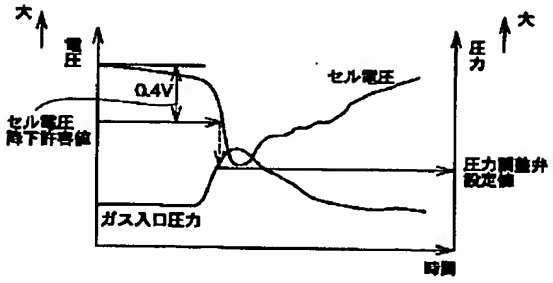
【符号の説明】

１　セパレータ
２　ガス入口マニホールド
３　ガス入口流路
４　発電部
５　ガス出口流路
６　ガス出口マニホールド
１０　バイパス流路
１１　圧力調整弁
１２　オリフィス

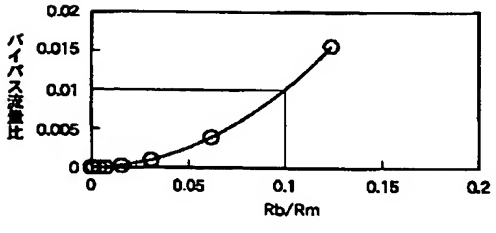
【図１】



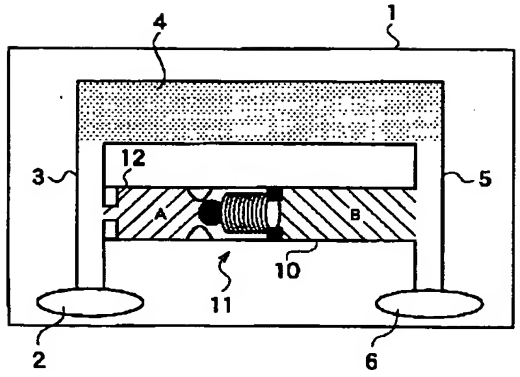
【図２】



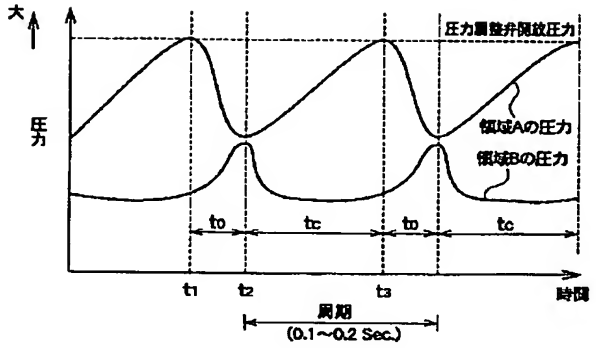
【図９】



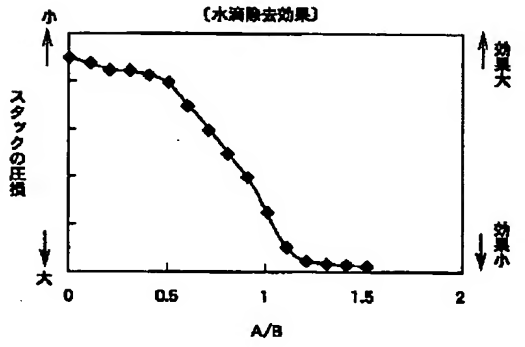
【図３】



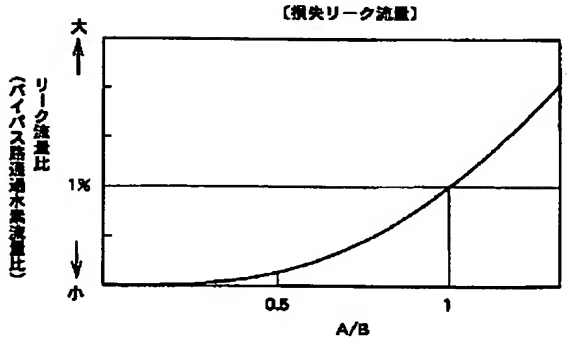
【図４】



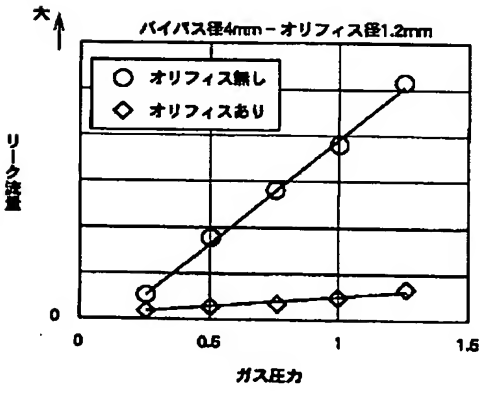
【図５】



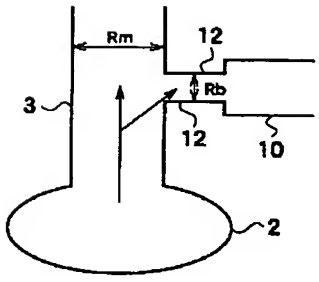
【図６】



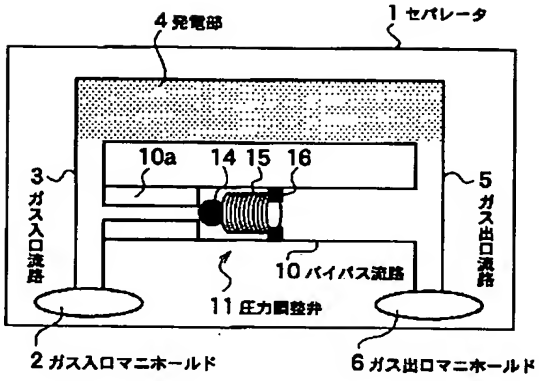
【図７】



【図８】



【図１０】


4 発電部
1 セパレータ
10a
14 15 16
3 ガス入口流路
5 ガス出口流路
10 バイパス流路
11 圧力調整弁
2 ガス入口マニホールド
6 ガス出口マニホールド